Center Independent Research & Development: KSC IRAD

Novel Concepts for Radiation Shielding Materials

Completed Technology Project (2012 - 2013)

Project Introduction

The likelihood of safely sending astronauts to Mars is becoming bleaker because of the health risks that would result from exposure to galactic cosmic radiation (GCR). The dilemma of how to best protect those astronauts has continued over the years, with evaluation of both radiation protection materials and vehicle design architectures for possible solutions. Recent studies reveal that polyethylene, a lightweight polymeric material that is a strong candidate for shielding radiation because of its high percentage of hydrogen, is not much better than the much heavier-weight metallic aluminum. Studies also suggest that earlier predictions that older astronauts would be more resistant to radiation than younger astronauts might not be valid. The breakthroughs needed for magnetic or electrostatic shielding to be feasible are likely many years away.

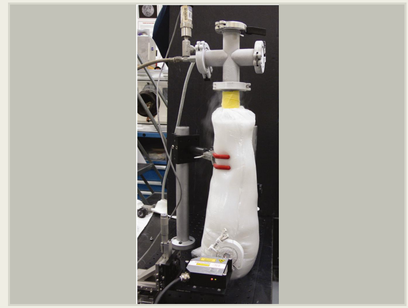
It is critical that safety factors be maximized with respect to long duration, extraterrestrial space flight. Any significant improvement in radiation protection will be critical in ensuring the safety of crew and hardware on such missions. The project goal was to study novel concepts for radiation shielding materials that can be used for long-duration space missions. As part of this project we investigated the use of thin films for the evaluation of a containment system that could retain liquid hydrogen and provide the necessary hydrogen density for effective shielding.

The technical challenge of this project was to identify or design/develop a polymeric/composite material, laminate system that can contain a large quantity of liquid hydrogen in deep space for Galactic Cosmic Radiation (GCR) shielding. This material/system must be strong enough to handle the pressure generated by this cryogenic material, yet maintain some degree of elasticity, even at liquid hydrogen temperatures (typically 20 K). It must be thin enough to minimize secondary particles from GCR, yet not allow the hydrogen to diffuse through it.

Finally, it would be desirable to have high emissivity at long wavelengths so that radiative cooling can occur. Specific architectural designs and thermal controls of hydrogen contaminant system were not addressed in this project. This project also aligns with joint activities currently being worked with other NASA centers and the integration of technologies that are considered necessary for future exploration.

Anticipated Benefits

The Agency cannot support human missions greater than approximately 90 to 100 days beyond low Earth orbit (LEO) without developing shielding and/or biological countermeasures to remain below Permissible Exposure Limits. As



Overview of test apparatus for cryogenic bulge testing

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Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Kennedy Space Center (KSC)

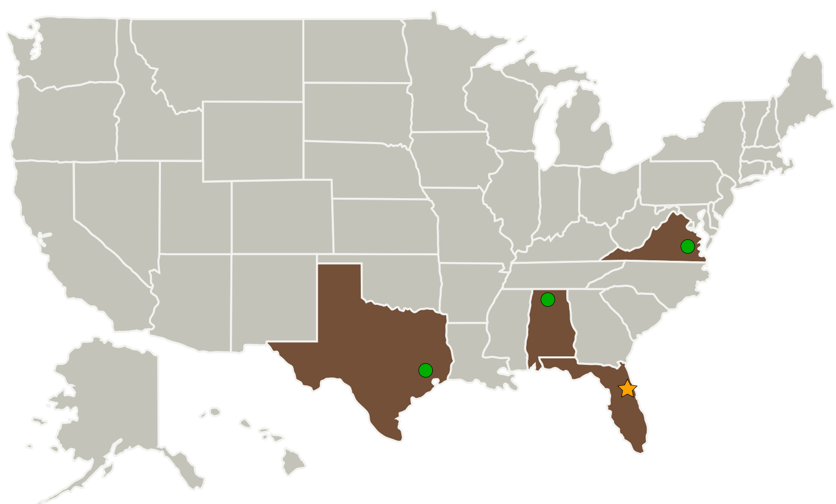
Responsible Program:

Center Independent Research & Development: KSC IRAD more advanced and prolonged human exploration of environments beyond earth are being considered, it is recognized that radiation protection will need to be optimized in order to safely carry out these missions. Even if only a marginal improvement in protection was observed by some of the concepts studied and light weight hydrogen containment could be realized and advanced, such an increase in protection could mean the difference to mission success or failure.

Advancement in this technology would ensure the safety of crew and hardware on future missions. Significant benefit could be expected by leveraging several different NASA centers’ radiation shielding activities and how they might be applicable to an integrated approach.

The proposed advances in radiation shielding are also applicable to non-space applications such as military operations; such as shielding troops of potential exposure to radiation.

Primary U.S. Work Locations and Key Partners



Project Management

Program Manager:

Barbara L Brown

Project Manager:

Nancy P Zeitlin

Principal Investigator:

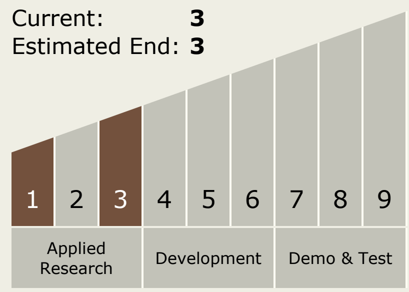
Martha K Williams

Co-Investigator:

Robert C Youngquist

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



Technology Areas

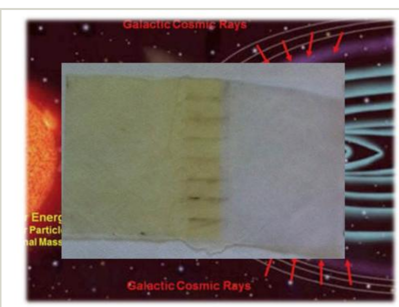
Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  └ TX06.5 Radiation
    └ TX06.5.3 Protection Systems

Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama
QinetiQ North America(QNA)	Supporting Organization	Industry	

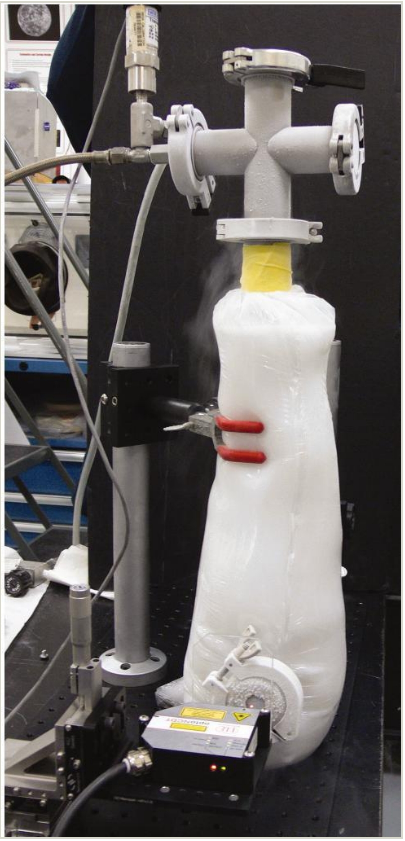
Primary U.S. Work Locations	
Alabama	Florida
Texas	Virginia

Images



Joining concept for polymer laminate system for possible H2 containment

Joining concept for polymer laminate system for possible H2 containment
(https://techport.nasa.gov/image/2691)



Overview of test apparatus for cryogenic bulge testing
Overview of test apparatus for cryogenic bulge testing
(https://techport.nasa.gov/image/3491)